Electric Light on the Farm and In the Rural Districts

EDISON LAMP WORKS
OF GENERAL ELECTRIC COMPANY

GENERAL SALES OFFICE
HARRISON, N. J.

Where Visitors to the Institute Are Received

Model Store of the Institute

Industrial Lighting Room

At the Edison Lighting Institute, dedicated to the public for the advancement of the art and science of illumination in its many and varied applications, are protrayed most dramatically hundreds of uses of light.

Electric Light on the Farm and in the Rural Districts

Information Compiled by
A. L. Powell and A. D. Bell
Engineering Department

Many farms, mainly of the purely residential type or show places, have grounds and gardens which are both extensive and beautiful. Their beauty ends, however, at nightfall. A few well placed lighting units, usually of the floodlighting type, will transform the shrubbery and flowers into fantastic and exquisite settings.

For information regarding MAZDA lamps and lighting questions, refer to the nearest sales office as listed on the last page of this bulletin.

To insure receipt of bulletins, notify the Department of Publicity, Edison Lamp Works of General Electric Company, Harrison, N. J., of any change of address.

Adequate illumination is an efficient aid on the farm as well as in the industrial plant.

A rather novel method of destroying insect pests has been successfully tried. It consists of suspending a lighted incandescent lamp over a pan of kerosene at night. The insects are attracted by the light and will fly against it, dropping into the liquid. An astonishing number of bugs may be disposed of in this manner during an evening as described in some of the references in the bibliography.

There is no doubt that some such system as this will lure to destruction the female codling moth before she has an opportunity to deposit her damaging eggs in the calyxes of the apple trees' pink blossoms. The leaf roller, the cherry maggot in its moth form, the rose aphis, and the cut and cabbage worms in winged forms may be trapped after being attracted by the light.

Electric Light on the Farm and In the Rural Districts

Information Compiled by A. L. Powell and A. D. Bell, Engineering Department

General Considerations

Accompanying its widespread use for commercial, industrial, and domestic purposes, electricity is being applied more and more to the needs of the farmer and the dweller in the rural districts. While the extension of central station power lines has been the chief factor in bringing this about, individual farm lighting plants are still being installed in those sections remote from high tension power lines.

On the well equipped farm today electricity will be found in use for both lighting and power purposes, yet it is the exception rather than the rule to find lighting which is really adequate.

There is probably no place where electricity renders greater service than on the farm. It is literally a 24-hour a day servant. Space does not permit a discussion of the power applications ranging from that of pumping water to operating the ensilage cutter, grindstone, and milking machine. A tabulation of the electric power time saving appliances in actual use would fill an entire page. We are especially interested in electricity converted into light, and the uses of electric light around the farm are more varied than in almost any other class of service. There is the illumination of the house itself for work, recreation, and decoration. The barns, outlying buildings, and yards have many needs for artificial light, but in addition to these more common uses, properly applied artificial illumination will increase egg production and speed the growth of plant life. Light may be used to lure harmful insects so that they may be destroyed, and a case is on record where an apiarist used a beam of electric light directed on the entrance of the hives to cause the bees to become active several weeks earlier than normal, with a resultant increase in honey. Ultra-violet radiation has been used successfully to prevent rickets in young chicks. The farmer may mount a portable floodlight on his tractor and continue work after dark if desired. Similar lighting to that used in excavating for large buildings can make harvesting a continuous operation.

The advantages of lighting by means of the incandescent lamp, as compared with the kerosene oil lamp or other exposed flame

illuminants, are well known and may be summarized as being more convenient, safer, and all around more satisfactory. In other words, it permits living in the country with greater comfort, as many of the daily chores and duties may be performed with less effort and with a considerable saving of time.

As a guide to improving conditions in existing installations and an attempt to insure new layouts meeting modern demands, we present in this publication a series of suggestions which are based on an extended series of investigations on actual farms. The recommendations are intensely practical and in no sense extravagant.

If lighting of the type described is provided, real economy in farm operations will result. Light is one of the least expensive tools at man's disposal. For example, a prominent agriculturist recently reported that good lighting in his stock sheds increased the speed of the workmen so that each saved one-half hour per day.

In providing a satisfactory electrical installation for both lighting and power purposes in farm buildings, it is desirable to follow certain well recognized forms of present day practice. Many farm buildings are simple in structure and there is a tendency to install very inexpensive wiring systems. Economy, of course, is usually required but in many cases a better sort of wiring system, such as BX cable, is desirable. It will last much longer than cheaper wiring and provides far greater safety.

All too often a minimum size of wire is installed; this produces considerable voltage drop,—a costly proposition,—and makes it unsafe to increase the load as new demands for electric service are experienced. It is much more satisfactory and far less expensive in the long run to make the initial job adequate for the future.

Outlets for illumination should be carefully placed and adequate means of control provided. Porcelain receptacles, switches, etc., are recommended for barns and outbuildings as these places are often damp, and it is well to use outlet box covers and other metal fittings of a non-corrosive type. Convenience outlets for power purposes are likewise essential.

Frequently bare lamps are used to provide illumination in farm buildings, and with the inside frosted types of MAZDA lamps this sort of lighting is often reasonably satisfactory. A large portion of the light rays are directed upward and laterally, however, and in most places the use of reflectors or shades will give better results, with the exception that when the ceiling is low and white in color, the ceiling itself will act as a reflector.

In the following pages are given lighting recommendations, both for the farm house and for the various buildings used in carrying on the daily routine work. These recommendations are intensely practical and their value has been shown in actual installations.

A good example of a parlor or living room lighted by a decorative semi-indirect fixture which uses a 100-watt MAZDA lamp.

Parlor or Living Room

Need for Illumination

Social gatherings and for general use of family for reading, sewing, music, study, etc.

Location of Outlets

One in center of ceiling for general illumination; convenience outlets about 12 feet apart for floor and table lamps; possible wall outlets for decorative brackets.

Size of MAZDA Lamps

With pendent fixture having several sockets, 40 or 50 watts in each socket. For indirect fixture with only one socket, 100 or 150 watts. Table lamps 40 to 60 watts.

Type of Reflector

Decorative semi-indirect fixture with one socket or multiple unit types are especially well adapted, giving soft, well diffused, evenly distributed general lighting. Personal taste will govern choice.

Mounting

Indirect types about two feet below, direct types close to ceiling.

Control

Wall switch located at most used entrance.

Night photograph of a farm house combination dining and living room, lighted by four 40-watt MAZDA lamps in a glass shaded pendent fixture. The light is fairly well diffused and not glaring. There is plenty of illumination on the table top as well as throughout the room.

Dining Room

Need for Illumination

Early morning and evening meals; for reading, sewing, etc.

Location of Outlets

One in ceiling over dining room table. One convenience outlet in floor under table for electrical appliances, also others in baseboard about 12 feet apart for these, and for lighting on the sideboard, etc.

Size of MAZDA Lamps

If the dome type of fixture is used over dining table—100 watts; if multiple arm pendent, semi-indirect or candlestick type—40 to 60 watts in each socket. Sideboard lights 15 to 25 watts.

Type of Reflector

The glass dome type is very well adapted as it directs light on the table and about room. Semi-indirect and candle types also suitable.

Mounting

Dome reflector 26 inches from table; others about 2ft. from ceiling.

Control

Wall switch at most used entrance.

Night photograph of a well-lighted farm kitchen. An enclosing globe of the typical "kitchen unit" type, with a 100-watt MAZDA lamp, gives well diffused, satisfactory illumination.

Kitchen

Need for Illumination

No place on the farm needs good illumination more than the kitchen, for it is there that many tasks are done; for example, cooking and baking, canning of fruits and vegetables, butchering duties, and in some cases care of the milk and butter-making.

Location of Outlets

If the room is less than 10 ft. x 14 ft., one outlet center of ceiling; for larger rooms two outlets, with individual outlets over sink and range, and convenience outlets for appliances, in each case.

Size of MAZDA Lamps

Ceiling outlet—100 watts; local lights—25 or 40 watts.

Type of Reflector

General lighting—opalescent glass diffusing globe. Local lighting—deep bowl opalescent glass.

Mounting

Central unit—close to ceiling. Local—about 5-6 feet above floor.

Control

Preferably wall switches, though pull chain sockets may be used

A bed room provided with adequate yet attractive illumination. There are three 40-watt MAZDA lamps in the ceiling fixture and one in the sidewall bracket. Note that the wall bracket is more decorative than useful, as a person standing in front of the mirror would receive little light on his face. A better arrangement would consist of two dressing table lights.

Bed Room

Need for Illumination

Retiring at night, early morning arising, etc.

Location of Outlets

One in center of ceiling for general lighting requirements. Convenience outlets for dresser lights and bed lamp.

Size of MAZDA Lamps

If semi-indirect center fixture with one socket—60 or 100 watts; if direct lighting type—40 or 60 watts in each socket. Dresser and bed lamps—25 or 40 watts.

Type of Reflector

Ceiling fixture of decorative semi-indirect variety is very satisfactory; direct pendent types are also good.

Mounting

Semi-indirect type suspended 1½-2 ft.; direct type close to ceiling.

Control

Wall switch near entrance door for ceiling fixture.

Night photograph in a farm house cellar. This portion of the cellar, housing the electric water pump as well as the refrigerating mechanism, is lighted by a 40-watt Mazda lamp in an RLM Standard dome reflector. The portable light on the extension cord, a convenience which may be used in any of the farm buildings, should be noted.

Miscellaneous Rooms

Bath Room

In the average bath room the most important place to light is the mirror, as this is necessary for shaving. Two wall brackets, one on each side of the mirror, using 25 or 40 watt Mazda lamps with diffusing glass shades, will give good illumination for the mirror and the rest of the room as well. Fairly good illumination may be obtained by using a single light over the top of the mirror, and with this arrangement a 50 or 60 watt Mazda lamp is desirable.

Halls

It is very essential to have enough light in halls and stairways so that it will be possible to move about the house at night without difficulty. The hall and stairway may be lighted at the same time by using a small enclosed glass globe with a 40 or 50 watt Mazda lamp hung from the hall ceiling but close to the stairway. Flexible control of the light for the stairway is very convenient, and with three-way switches it may be controlled from either the head or the foot of the stairs.

Porches

The porch at the front of the house needs a light to illuminate the steps and entrance. A glass enclosing globe, suspended with a tight fitting ceiling type holder, to keep out bugs and dirt, is recommended, and it should be supplied with a 25 or 40 watt MAZDA lamp. An open type of glass shade may also be used to good advantage.

The rear porch is sometimes screened and is used as a summer kitchen. To provide the necessary illumination an RLM Standard dome reflector with a 100 watt MAZDA lamp is recommended. One or more convenience outlets should be installed to take care of an electric iron and other appliances.

Closets and Storerooms

In the closets and storerooms, which are often of considerable size and should be provided with lights, a single light consisting of a 25 or 40 watt MAZDA lamp with a pull chain socket will generally be sufficient, and in the smaller closets a 15 watt MAZDA lamp will be large enough.

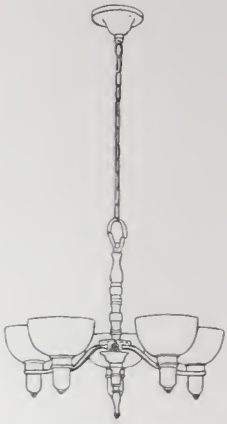
Cellar

On account of frequent use the cellar should be adequately lighted. A 25 or 40 watt MAZDA lamp should be placed at the foot of the stairs with switch control at the top. A similar light is also desirable at the top of the stairs. One or more lights should be available in the cellar itself, depending on how the space is arranged. For the furnace a 50 or 60 watt MAZDA lamp in an RLM Standard dome reflector is recommended, hung close to the ceiling.

A well lighted work bench facilitates making with accuracy the necessary repairs to farm machinery.

Dining room fixture of candlestick type

Flared dome for dining room



Semi-indirect fixture for parlor or living room

Kitchen lighting unit

An enclosed type of porch light

Bed room dressing table lamp used in pairs

Typical residential lighting fixtures suitable for the farm house

A semi-indirect bowl for the bed room

Photograph of a well-lighted haymow as it appears at night. A 100-watt MAZDA lamp in an RLM dome reflector can be seen at the right rear, a similar unit is at the left foreground, out of the field of the camera. This makes pitching down hay a much different job than under the usual conditions of darkness and gloom, and the main floor is also well lighted.

Main Barn

Need for Illumination

Pitching down hay to the stock at any time, driving in or out at night, unharnessing.

Location of Outlets

Over center of haymow areas and main floor. In case there is a hay fork the lighting units must be located so as not to be damaged.

Size of MAZDA *Lamp*

100 or 150 watts.

Type of Reflector

Shallow dome; reflector tilted if necessary for proper distribution.

Mounting

As high as possible, so as to give wide distribution of light.

Control

Wall switch for light over floor near entrance door; for other lights, switch near ladder to mow.

Night view of a cow stable lighted by 40-watt MAZDA lamps spaced on centers 7 ft. by 10 ft. The milking, feeding, and tending the cows here may be carried on at night as well as in the day time for the light is well distributed in all directions. Such conditions likewise make it easier to keep the stable and the cows cleaner, which will in turn tend to keep the bacterial content of the milk lower.

Horse or Cow Stables

Need for Illumination

Harnessing, cleaning of horses and stables, and feeding during hours when it is dark. Feeding and milking of cows carried on after dark, particularly in winter.

Location of Outlets

For straight stalls a row of outlets over the rear of the stalls on 12 to 15-foot centers; for box stalls one outlet in center of each.

Size of MAZDA Lamp

40, 50, or 60 watt.

Type of Reflector

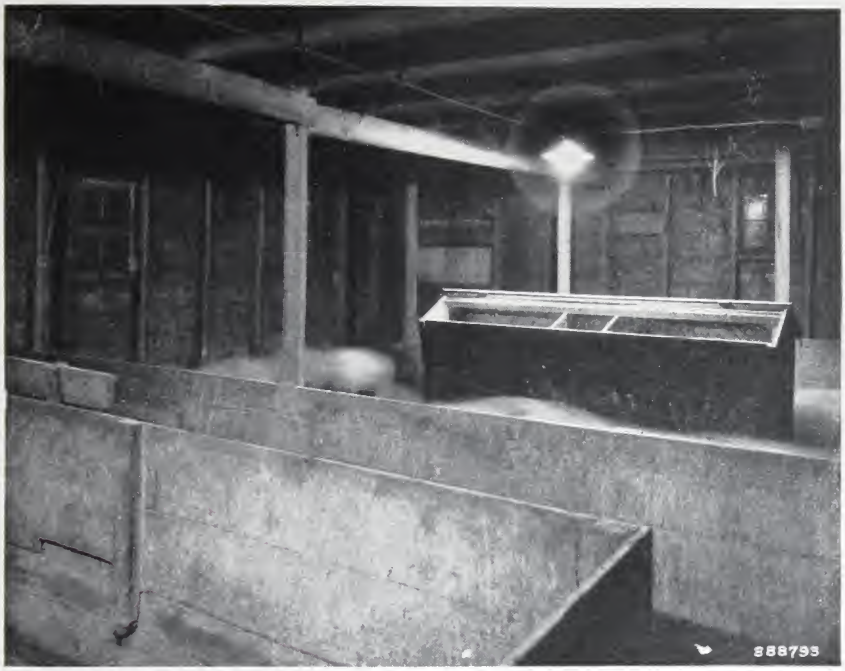
Shallow dome, or if ceiling is whitewashed, receptacle on ceiling and bare lamp.

Mounting

Close to ceiling, if ceiling is not over 9 feet high.

Control

For straight stalls wall switch for at least one outlet, switch to be located near entrance door, other outlets may be with pull sockets for economical operation; for box stall, switch outside door.



Night photograph of a hog house lighted by two 60-watt MAZDA lamps in shallow dome reflectors spaced on 13-foot centers. The lighting here is well distributed and permits the feeding and caring for the hogs as easily after dark as during the daytime.

Hog house or Sheep Barn

Need for Illumination

Chiefly for feeding after dark, and tending young.

Location of Outlets

On 10 to 15-foot centers.

Size of MAZDA Lamp

40 or 50 watt.

Type of Reflector

Shallow dome or RLM Standard dome.

Mounting

Close to ceiling if ceiling is not over 10 feet high.

Control

Wall switch near entrance door.

Night view of a granary lighted by two 60-watt MAZDA lamps in shallow dome reflectors spaced on 12-foot centers. Sufficient light is provided in the bins on account of the wide distribution of this type of reflector and there is ample illumination for feed grinding, which is becoming an important factor on the farm equipped with electricity.

Granary

Need for Illumination

Getting and grinding feed during hours of darkness.

Location of Outlets

Center of room.

Size of MAZDA Lamp

40, 50, or 60 watts.

Type of Reflector

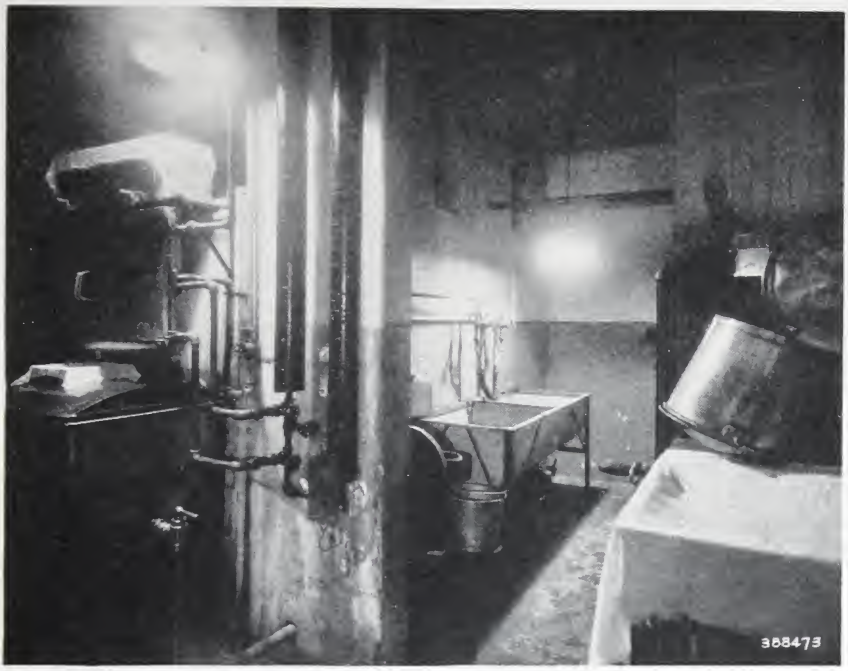
Shallow dome or RLM Standard dome.

Mounting

Close to ceiling, if ceiling is not over 10 feet high.

Control

Wall switch by entrance door.



A dairy room as it appears after dark, lighted by 60-watt MAZDA lamps in RLM Standard dome reflectors located with reference to the machines. With lighting such as this milk and cream can be cared for with dispatch and in a sanitary manner.

Dairy Room or Milk House

Need for Illumination

Cooling, separating, and bottling of milk during hours of darkness.

Location of Outlets

Localized according to arrangement of place, not over 10 ft. apart.

Size of MAZDA Lamp

50 or 60 watts.

Type of Reflector

RLM Standard dome. If area is small and walls are whitewashed, ceiling or side wall receptacles and bare lamps may be used.

Mounting

Close to ceiling if ceiling is not over 10 feet high.

Control

Wall switch by entrance door preferable, though individual pull chain sockets may be employed.

Night photograph of a garage and tool shed in which the lighting is a decided asset. Repairs and adjustments can be carried on here at will, irrespective of daylight conditions. Note that a convenience outlet for power appliances is located over the work bench.

Tool Shed or Garage

Need for Illumination

Repairs on dark days or during hours of darkness.

Location of Outlets

At least one in center of area or over hood of car for general lighting; one over work bench. In large garage one over hood of each car.

Size of MAZDA *Lamp*

60 or 100 watts for general lighting; 50 or 60 watts for bench.

Type of Reflector

RLM Standard dome.

Mounting

9 to 11 feet from floor for central lighting unit; 7 feet from floor for lighting unit over bench.

Control

Wall switch near entrance door for central light; pull chain porcelain socket for light over bench.

A silo chute as it appears when lighted at night, looking down from the top of the ladder. A 100-watt unit furnishes the illumination which certainly makes it easy to see one's way up and down the ladder. Note that there is plenty of light at the different door levels of the silo.

Silo

Need for Illumination

Filling silo and removing silage at any time.

Location of Outlets

One outlet at top of chute generally sufficient.

Size of MAZDA Lamp

100 watts.

Type of Reflector

RLM Standard dome.

Mounting

Outlet to be at top of chute.

Control

Wall switch at bottom of ladder.

A typical farm yard as it appears after dark. The illumination is provided by four 100-watt MAZDA lamps in RLM Standard dome reflectors, two of the units being suspended from poles by brackets and two from the sides of the barn.

Yards

Need for Illumination

Feeding and watering the stock, driving in the animals after dark, unharnessing, returning home during evening, storing machinery.

Location of Outlets

In general, on 25 or 35-foot centers; if buildings are grouped together a single light may often serve.

Size of MAZDA Lamp

If several outlets—60 or 100 watts; for a single unit system 200 to 500 watts.

Type of Reflectors

Shallow dome weatherproof, giving wide distribution of light. Holders should be durable to withstand wind and storms.

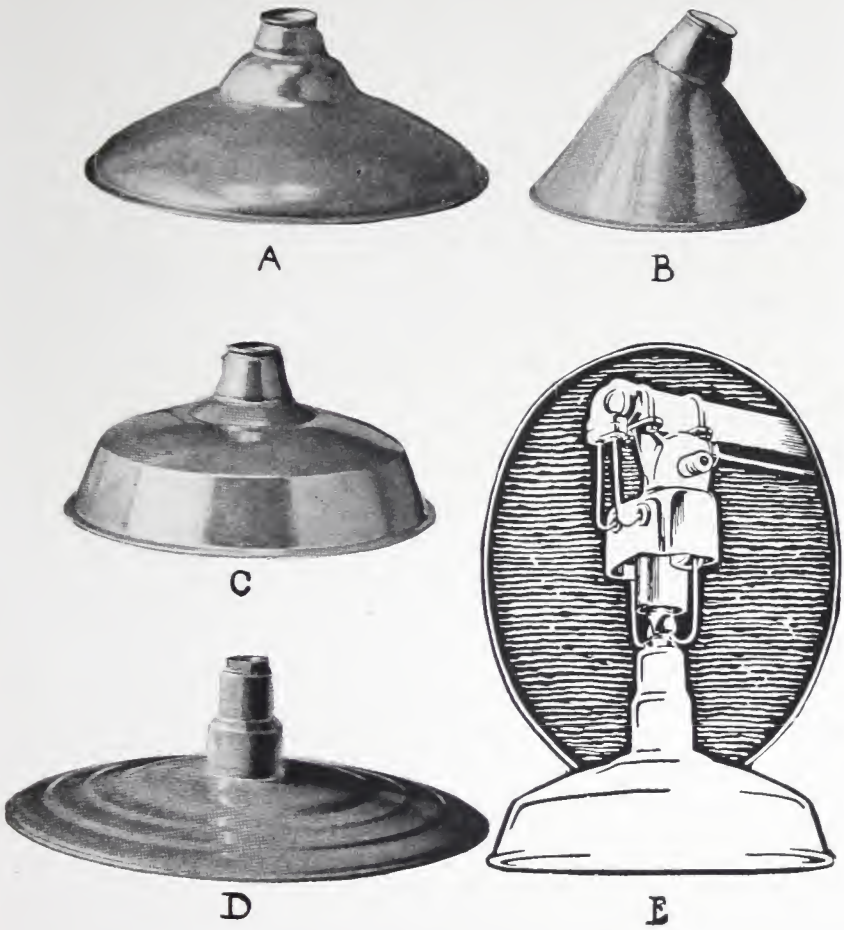
Mounting

15 to 25 feet on brackets from building or pole.

Control

By wall switches located at most convenient places; if out-of-doors they should be weatherproof type. Three-way control, one switch at house and one at barn, recommended.

NOTE: Where the area is very extensive and there is danger of theft, such as of poultry, fruit, etc., it is even feasible to provide floodlighting for distant buildings, having the control from a convenient place in the house, probably in the owner's bedroom.



Types of reflecting equipment recommended in the text for use in and about farm buildings.

A—Shallow dome porcelain enameled steel reflector
B—Angle reflector of porcelain enameled steel
C—RLM Standard dome reflector
D—Flat reflector of porcelain enameled steel (chiefly for yard lighting)
E—RLM Standard dome reflector showing lowering device for high mounting.

Night photograph of typical district school. Six 200-watt MAZDA lamps in diffusing globes spaced on centers 11 x 12 feet furnish good light.

Rural Schools

Need for Illumination

Builders of schools generally appreciate the importance of having good natural light and, as a rule, adequate window areas are usually provided. Proper artificial lighting is just as essential, for the school period (September to June) contains many dark and stormy days; and there is no good reason why the children in the rural schools should work under the handicap of eyestrain when good illumination is available at a comparatively low cost. Too often any means of supplying artificial light is lacking.

Location of Outlets

For average size room (24 ft. x 32 ft.), 6 outlets on 10-12-ft. centers.

Size of MAZDA Lamps

200 watts if ceiling is light in color, otherwise 300 watts.

Type of Reflector

Opalescent glass enclosing globes.

Mounting

10 to 12 feet; that is, close to ceiling.

Control

Wall switches near entrance door with at least two circuits.

The community hall is a gathering place for fraternal meetings, dances, shows, etc. Elaborate lighting effects are not necessary, but good, workable illumination is. Semi-indirect reflectors or enclosing globes are recommended with not less than 150-watt MAZDA lamps on 12-foot centers.

Night view of the interior of a hen house lighted by two 50-watt MAZDA lamps in distributing metal reflectors. Instead of using a dimming device to simulate twilight the practice is followed of turning off the main lights and leaving a 10-watt lamp burning while the birds get on the roosts.

Light and Egg Production

The domestic hen originally came from the tropics and for centuries she was accustomed to a twelve-hour day and twelve-hour night. Her habits of life being based on these conditions naturally affected her organs, especially those of digestion; consequently when she is forced to live in the northern latitudes with their short days in winter she goes to roost early, her crop becomes empty long before daylight, and her bodily functions are upset. All of her food is needed to keep her alive and her body warm and there is no surplus to be turned into eggs. She really is ready to lay eggs during the winter months, but, being restrained by environment, practically hibernates.

By using artificial illumination it is possible to lengthen the feeding and laying period. This may be done by "lighting up" during the early evening hours and early morning hours. To do this effectively automatic switching devices to regulate the lights are desirable, and of late it is becoming the practice to turn on the lights only during the early morning hours, which can be done without elaborate switching; a controlling switch in the house is all that is necessary. It requires the poultry man to turn it on rather early, but as he often is an early riser this is no hardship. An automatic device only to turn on the lights is also rather simple.

In case the lights are used in the early evening it is necessary to dim them before shutting them off entirely, or perhaps turn on another circuit using very low wattage lamps, in order to get the fowls to go to roost. They are not able to go to roost when it suddenly becomes dark, as they will fly all over the place and into each other. By only using the lighting early in the morning and turning it off after daylight there is no necessity for such dimming devices.

If the artificial illumination is used only in the early morning hours, the time for turning them on should be approximately five o'clock in the morning, the idea being to give the fowls on the average a twelve or thirteen hour day. The exact time for turning on the lights must be determined by the length of the hours of daylight; in the fall it gradually becomes darker, and, accordingly, the lights should gradually be turned on earlier and earlier. After December 21st the days lengthen and the lights are turned on later.

A group of poultry houses which have proved a very good investment due to the fact that artificial light causes increased egg production in the winter months.

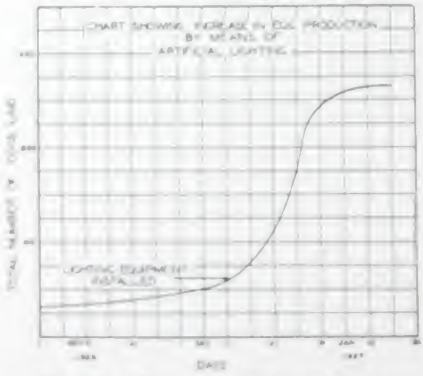
Another important feature in the poultry house is water, and it is quite evident that water in an ordinary container will freeze over night and be of no use to the hens. It is a simple matter to make a device which will prevent the water from freezing: in the bottom of an ordinary water pail a 3-inch hole is cut, a tin can is placed in the pail over the hole and soldered to the bottom of the pail. A small incandescent lamp is left burning within this can (a 15 watt MAZDA lamp will generally be adequate). The radiated heat from the lamp will insure water, not ice, for the hens in the morning.

Further details on the question of the proper schedule and feeding will be found in the numerous references in the bibliography.

To provide suitable artificial illumination for the hen house, relatively small MAZDA lamps, proper reflectors, and some controlling device are all that are needed. A high intensity of illumination is not necessary for satisfactory results; an allowance of one 50 or 60 watt MAZDA lamp for each 100 square feet of floor area is sufficient. The light should be uniformly distributed over the entire floor space. For the average conditions of spacing and hanging height encountered in this type of building, the shallow dome metal reflector, which distributes the light over a wide angle, should be used. Do not make the mistake of using a narrow cone shaped reflector, which concentrates the light in a small angle. For a square room one lamp should be used in the center of the room, but in a long narrow house as pictured on page 27, a row of outlets down the center line should be installed; thus a hen house 10 x 25 feet would be well illuminated by two 50 or 60 watt MAZDA lamps with distributing reflectors, hung close to the roof and spaced 12 feet apart.

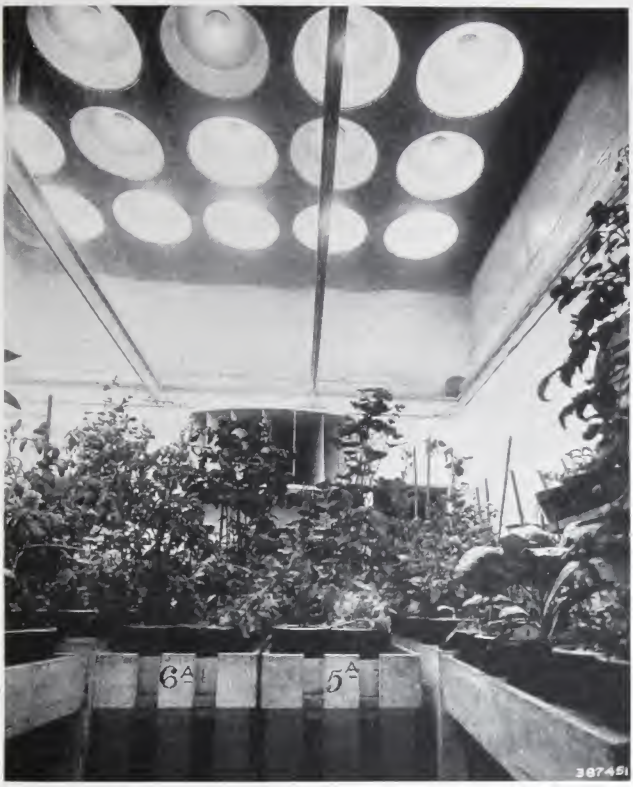
It might be well to summarize conditions requisite for success in increasing egg production, through the use of artificial light:

1. Morning light should be used only when feed and water, not ice water, is provided.
2. Increase the day gradually in the fall and do not turn off the light too quickly in the spring.
3. Use the lighting system regularly.



Results of a test conducted by the Charlton Poultry Farm. This notable increase in egg production from 540 hens was obtained with a lighting system costing only $42 to install and but 16 cents per day to operate.

Electricity is not only of value to the farmer in increasing egg production, but electrical heat for incubators can be strongly recommended as it has been found to be very constant, reliable, and safe. Artificial illumination is at times necessary in the incubator room and should be available. RLM Standard dome reflectors with 50 or 60 watt MAZDA lamps should be hung directly over those areas where light is most needed.



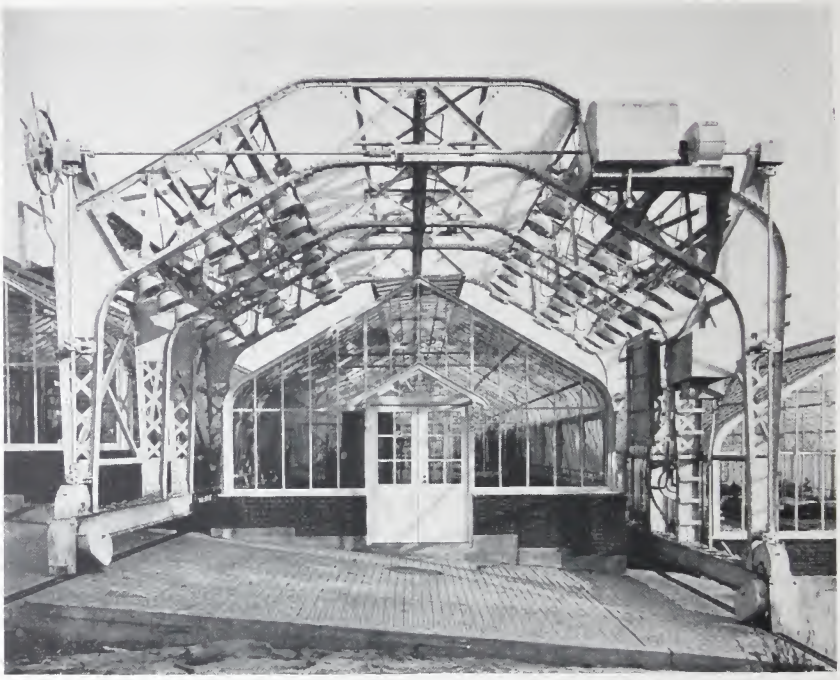
A room in which plants are experimentally grown under artificial illumination of a high intensity.

Light and Plant Growth

The influence of artificial light on the growth of plants has long been a subject of interest to the scientist. As far back as 1861, "Herve" Mangon found that electric light influenced the formation of chlorophyl in a way similar to that of daylight. Since then, at frequent intervals, experiments have been reported in the technical press. Recently, however, with the development of more efficient light sources such as the MAZDA lamp there has been a renewed interest in the subject and more tangible results have been secured.

It has been quite definitely proven that artificial light will accelerate germination, increase growth, give greater depth of color, and more important still, show no signs of the lanky, unnatural extension of the plant usually associated with forcing. Under artificial light seeds germinate several days, in some cases weeks, before those sown and grown under precisely similar conditions in a control house. The quality of such seedlings is good, stems sturdy, and leaves strong, the flowering plants showing an increase in foliage and flowers. Plants grown under artificial light seem to require less heating and the seedlings less "hardening off," before being planted in the open.

Plant physiologists realize that there are many factors affecting plant growth. These include temperature, moisture, carbon dioxide supply, and period of exposure to light. As with many experiments, to determine the effect of varying one element, other factors must be held constant. The control of these factors obviously requires rather elaborate and expensive apparatus.



An electric crane with 48 1000-watt MAZDA lamps used for growing plants experimentally at night. The crane may be moved from one greenhouse to another.

Most of the early experiments of the effect of light on plant growth were conducted in a rather haphazard manner, but a few years ago work was started in a most systematic and scientific manner at the Boyce-Thompson Institute for Plant Research, Yonkers, New York, under the direction of Dr. William Crocker, the eminent plant physiologist, and we are now beginning to know more definitely than ever before the relations which exist between the various items which influence plant life.

Messrs. Garner and Allard, physiologists of the Bureau of Plant Industry, Department of Agriculture, were probably the first to prove that "the relative length of day is a factor of the first im-

portance in the growth and development of plants particularly with respect to sexual reproduction."

Expressed briefly they determined that each species of plant has certain peculiar habits which are affected by the relative proportion of light and darkness during a day's cycle. Sexual reproduction can only be attained when the plants are exposed to the specifically favorable length of day. A greater length of day will cause certain species to grow more or less indefinitely and not flower or fruit, while causing other types to flower and fruit with less than normal vegetable development. Plants may be either late or early maturing, depending on the length of day to which they are exposed. Several species when exposed to a length of day distinctly favorable to both growth and sexual reproduction have shown a tendency to assume the "ever blooming" or "ever bearing" type of development.

These investigators have further determined that artificial light can be used as a means of prolonging the length of day. This fact should be of much interest to horticulturists and agriculturists, for in a given latitude the length of day at certain times of the year is, of course, definitely fixed by nature. In summer the day may be longer than required for the particular effect desired (vegetation or fruiting) while in winter it is quite likely to be shorter than desired. By shutting out natural light in summer or supplying artificial light in winter excellent control is possible.

The experiments conducted by the investigators above referred to indicate that there is a large group of plants which are brought into the flowering and fruiting stages of development because of the increase in length of day as spring advances into summer. These may be spoken of as "long day plants" in contrast to those which are forced into flowering and fruiting by the shortening of the days in the fall which may be called "short day plants." As a whole there are sharp contrasts between the two groups although there are many plants which may be regarded as occupying an intermediate position. As illustrations of these groups we find in the short day plants, asters, chrysanthemums, dahlias, poinsettias, cosmos, and certain varieties of tobacco and beans. In the long day group are most of the so-called winter annuals and most of our common vegetables.

Artificial light properly used to supplement daylight during the short days of winter effectively prevents many of the "short day plants" from flowering and forces "long day plants" into flowering and fruiting. With the proper control of temperature and other important factors of plant growth, there is no reason why almost

any plant may not be made to flower and fruit in any season of the year and in any region. With proper knowledge of the specific requirements of each plant the florist should be able to force flowering at any desired time of the year. This is especially practical due to the fact that a comparatively low intensity of artificial light, in comparison with natural light, can be used to supplement the short days of winter.

It is evident that the entire question is one of economics. Does the hastening of plant growth, fruiting or flowering, warrant the expenditure for electrical energy? In answer to this, one must make computations applicable to individual instances. In the case of hothouse flowers produced out of season or made available for a certain holiday, such as Easter, it is quite evident that the added value of the crop at a particular time will be much greater than the cost of lighting. Lettuce responds very effectively to increased illumination and heading has been hastened two weeks in certain cases. Strawberries are reported to grow vigorously and have ripened from two weeks to a month earlier than normal with additional lighting.

We have not yet reached the point where it is economical to light large outdoor areas to hasten plant growth. Rough calculation indicates that, neglecting installation expenses, etc., the cost of lighting an acre would be well over $10 per night. The added growth would not be sufficient to justify an expenditure of this order when we consider the relatively low price for farm products grown on an extensive scale.

In contrast to this we have the case where such plants as Easter lilies are placed close together in a greenhouse. A few lamps will light a large number of plants, the product is seasonable and high priced, and flowering will be accelerated. In such a case the economics of the situation are entirely reversed and the expenditure for current, lamps, and wiring is indeed well justified. If power costs five cents per kilowatt-hour the expense of lighting 1000 square feet would be slightly over one dollar per night. As a typical example, in this area could be placed nearly 2000 Easter lily plants. If by artificial lighting they could be forced a week or two at the critical season, the expenditure for power would be dwarfed by the increase in value.

A 200 watt MAZDA lamp in an RLM reflector about two feet above seedlings works out very well to control "damping off." To prevent the seedlings becoming spindly a mixture of half sand and half garden soil should be used to afford good drainage and reduce

nitrification. Such lamps should be turned on as soon as the seed is planted and not turned off, except on bright sunny days, until the seedlings are transplanted.

With all this work there is quite apparently a limit beyond which the plant cannot be forced, and further study is indeed necessary. While certain flowers, such as tulips, are reported to have longer stems, richer color, and larger leaves when exposed to artificial light, others such as petunias, verbenas, and primroses, are reported to have been injured.

The agriculturist who is making a serious study of his business should analyze the information presented in the numerous articles listed in the Bibliography on the effect of light on plant growth.

Bibliography—*General*

"Electricity on the Farm, Bibliography," *Electrical World*, August 18, 1923.

"Application of Electricity to Farming," *Electrical Review*, London, November 18, 1921.

"Electricity on Western Farms," R. Sibley, *Electrical Merchandising*, April, 1920.

"Engineering Features Essential to the Success of the Farm Lighting Business," E. J. Edwards, *Electrical Contractor-Dealer*, August, 1918.

"Use of Electricity on Dairy Farms to Increase Production," *Electrical Review*, December 28, 1918.

"Use of Electrical Energy in Agriculture," *Electrical World*, February 3, 1923.

"Electricity on the Farm," R. A. Pearson, *General Electric Review*, December, 1927.

"The Economic Use of Electric Light on the Farm," *Illuminating Engineer* (British), July, 1926.

"Electricity on the Farm Pays," *Electrical World*, September 11, 1926.

"Lighting Layouts Around the Farm," A. D. Bell, *Farm Electric Dealer*, June, 1926.

"Better Lighting on the Farm," *Electrical Merchandising*, September, 1926.

"Lighting Farm Buildings," Douglas Dow and A. D. Bell, *Electrical World*, April 6, 1929.

Electric Service

"Giving Electric Service in Agricultural Districts," *Electrical World*, May 8, 1920.

"Serving Rural Distribution from High Tension Lines," *Electrical World*, April 16, 1921.

"Rural Service Charges," *Electrical World*, April 14, 1923.

"Wrong Impression Conveyed Regarding Cost of Rural Service," *Electrical World*, December 25, 1920.

"Review of Some Rural Line Fundamentals," *Electrical World*, December 24, 1921.

"Rural Electric Service Costs Analyzed," *Electrical World*, September 23, 1922.

"Giving Service in Agricultural Districts," *Electrical World*, May 8, 1920.

"Utilities Should Maintain But Not Invest in Rural Lines," *Electrical World*, July 23, 1921.

"Profitable Field for Rural Service Lines," *Electrical World*, June 18, 1921.

"Rural Rates Should be Based on Value of Service," *Electrical World*, May 14, 1921.

"Progress in Rural Service—Study I"—*Electrical World*, December 13, 1924, p. 1253.

"What the Farmer Thinks of Electricity," J. H. Flessner, *Nat'l Elec. Light Ass'n Bulletin*, September, 1928.

Bibliography (*Continued*)

"Four Years of Rural Electrification at Red Wing," C. F. Stewart, *Nat'l Elec. Light Ass'n Bulletin*, August, 1928.

"Electricity Consumption on the Farm," F. D. Paine, *Electrical World*, April 21, 1928.

"Electric Service for the Iowa Farm," *Reports No. 3* and *No. 4*, by F. D. Paine and Frank J. Zink, published by Iowa State College, Ames, Iowa.

"Power on the Farm," *Electrical World*, January 31, 1925, p. 239.

"Farm Electrification in New York State," O. D. Young, *General Electric Review*, April, 1925, p. 214.

"Status of Rural Electrification," Allen M. Perry, *Electrical World*, June 6, 1925, p. 1211.

"Some Difficulties and Possible Remedies Standing Before Rural Electrification," W. M. Jardine, *National Electric Light Association Bulletin*, July, 1925, p. 446.

"Important Phases of the Rural Electric Service Problem," Dr. E. A. White, *National Electric Light Association Bulletin*, July, 1925, p. 448.

"Rural Electrification," Robert H. Rogers, *General Electric Review*, September, 1925, p. 634.

Light and Plant Growth

"Flame Arc Lamps for Stimulating Plant Life," *Popular Electricity*, March, 1913.

"Mercury Vapor Lamps for Plant Growth," *Electrician* (London), September 25, 1913.

"Electric Light in Horticulture," (Editorial), *Electrical World*, October 18, 1913.

"Experiments in Electro-culture near Dayton, Ohio," H. G. Dorsey, *Electrical World*, December 13, 1913.

"Stimulating Plant Growth with X-Ray," *Scientific American*, March 28, 1914.

"Electro-culture, A Résumé of the Literature," H. R. Hosmer, *General Electric Review*, January, 1915.

"Effect of Artificial Light on the Growth and Ripening of Plants," J. L. R. Hayden, and C. P. Steinmetz, *General Electric Review*, March, 1918.

"Putting Plants on Daylight Rations," *Scientific American*, June 5, 1920.

"Flowering and Fruiting of Plants as Controlled by the Length of Day," W. W. Garner, and H. A. Allard, *Year Book*, U. S. Department of Agriculture, 1920, p. 377.

"Effect of the Relative Length of Day and Night and Other Factors of the Environment on the Growth and Reproduction in Plants, W. W. Garner and H. A. Allard, *Journal of Agricultural Research*, March 1, 1920.

"Response of Plants to Artificial Light," G. E. Stone, *Cyclopedia of American Agriculture*, Vol. 2, Crops, p. 22.

"Reports on Electro-horticulture," L. H. Bailey, N. Y. (Cornell) Agr. Exp. Sta., *Bulletin 30*, p. 83; *Bulletin 42*, p. 133; *Bulletin 55*, p. 147.

"A Study of the Effect of Incandescent Gas Light on Plant Growth," L. C. Corbett, W. Va. Agr. Exp. Sta., *Bulletin 62*, p. 77.

"The Influence of Light and Darkness Upon Growth and Development," D. T. MacDougal, *Mem. N. Y. Bot. Gard.*, Vol. 2.

"Electro-horticulture with the Incandescent Lamp," F. W. Rane, W. Va. Exp. Sta., *Bulletin 37*.

"Carbohydrate Production and Growth in Plants under Artificial Light," R. B. Harvey, *Transactions I.E.S.*, Vol. 19, p. 311.

"Preliminary Studies in the Response of Plants to Artificial Light," Hugh Findley, *Transactions I.E.S.*, Vol. 19, p. 318.

"Further Studies in Photoperiodism; the Response of the Plant to Relative Length of Day and Night," W. W. Garner and H. A. Allard, *Journal of Agricultural Research*, March 17, 1923.

"Electro-culture," L. J. Briggs, A. B. Campbell, R. H. Heald, L. H. Flint, U. S. Department of Agriculture, *Dept. Bul. 1379*.

"Effect of Sunlight on Growth and Development of Plants," W. T. Bovin, *Scientific Monthly*, July, 1925.

"Summary of Literature on Some Phases of the Effect of Light on Plant Growth," H. W. Popp, *Transactions I.E.S.*, Vol. 19, p. 981.

Bibliography (*Continued*)

"Influence of Color Light on Plant Growth," S. G. Hibben, *Transactions I.E.S.*, Vol. 19, p. 1000.

"Stimulation of Plant Growth by Means of Electric Lighting," V. A. Tiedjens, *Transactions I.E.S.*, Vol. 19, p. 1011.

"The Use of Electric Light to Stimulate Plant Life," Arthur Williams, *The Central Station*, October, 1925, p. 117.

"Work to Date at Boyce-Thompson Institute for Plant Research on Effect of Light on Plant Growth," J. M. Arthur, *Transactions I.E.S.*, Vol. 19, p. 995.

"Effect of Light, Carbon Dioxide and Temperature on Flower and Fruit Productions," J. M. Arthur and J. D. Guthrie, *Memoirs of the Horticultural Society of New York*, July, 1927.

"Some Effects of Light and Carbon Dioxide on the Growth and Flowering of Plants," J. M. Arthur, *Physical Therapeutics*, March, 1928.

"Microchemical and Morphological Studies of Effect of Light on Plants," Norma E. Pfeiffer, *The Botanical Gazette*, April, 1926.

"Artificial Climate and Plant Growth," J. M. Arthur, *The Tech. Engineering News*, April, 1928.

Egg Production

"How Artificial Light Increases Egg Production," E. A. Ridinor, *Poultry Success*, November, 1920.

"Big Profits by the Use of Artificial Light," *Reliable Poultry Journal*, October, 1920.

"Use of Artificial Light for Poultry Raising," *Reliable Poultry Journal*, July, 1919.

"Economics of Artificial Illumination," H. R. Lewis, *N. J. Agricultural Experimental Station Bulletin*, October, 1920.

"Artificial Light an Aid to Egg Production," J. E. Rice, *Cornell Countryman*, February, 1919.

"Use of Artificial Light to Increase Egg Production," G. M. Curtis, Booklet published by Reliable Poultry Journal Publishing Co.

"Poultryman Number," *Willys Light Sales Facts*, December 15, 1922.

"The Miracle of More Eggs," F. E. Brimmer, published by Delco Light Co.

"Will the Plant Increase Egg Production," F. E. Brimmer, *Farm Light & Power*, May, 1921.

"Electricity Necessary on Poultry Farms," H. L. Miner, *Farm Light & Power*, April, 1921.

"New York State College of Agriculture Experiments in Egg Production," *Electrical Merchandising*, April, 1920.

"An Electrified Poultry Farm," *Electrical Record*, May, 1914.

"The Use of Artificial Light to Increase Winter Egg Production," J. E. Dougherty, *Agricultural Engineering*, December, 1927.

"Artificial Illumination of Poultry Houses for Winter Egg Production," F. L. Fairbanks, published by N. Y. State College of Agriculture at Cornell University, Ithaca, N. Y.

"Electricity on the Farm Pays," *Electrical World*, September 11, 1926.

Bug Control

"Bright Lights Lure Tent Caterpillars," *Journal A.I.E.E.*, August, 1927.

"Infestation of Tomatoes Prevented by Lights," *Electrical World*, October 8, 1928.

"Electric Lights Mobilize Texas Crickets," *Electrical World*, October 2, 1915.

"Light-Traps in the Control of Insects," Luckiesh, Holladay, and Taylor, *Journal Franklin Institute*, July, 1929.

EDISON LAMP WORKS
OF
GENERAL ELECTRIC COMPANY

GENERAL SALES OFFICE, *HARRISON, N. J.
SALES OFFICES (address nearest office)

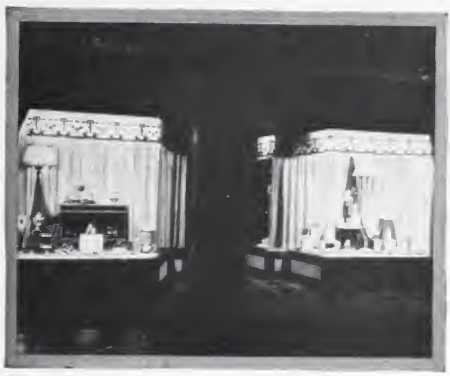
AKRON, OHIO, 159 South Main St.
*ATLANTA, GA., 187 Spring St., N. W.
BALTIMORE, MD., 39 W. Lexington St.
BIRMINGHAM, ALA., 602 North 18th St.
BLUEFIELD, W. VA., 307 Federal St.
*BOSTON, MASS., 84 State St.
*BUFFALO, N. Y., 39 East Genesee St.
*BUTTE, MONT., 20 W. Granite St.
CANTON, OHIO, 700 Tuscarawas St., W.
CHARLESTON, W. VA., 201 Capitol St.
CHARLOTTE, N. C., 200 So. Tryon St.
CHATTANOOGA, TENN., 536 Market St.
*CHICAGO, ILL., 230 South Clark St.
*CINCINNATI, OHIO, 215 West Third St.
*CLEVELAND, OHIO, 925 Euclid Ave.
COLUMBUS, OHIO, 17 South High St.
*DALLAS, TEXAS, 1801 North Lamar St.
DAVENPORT, IA., 111 East Third St.
DAYTON, OHIO, 25 North Main St.
*DENVER, COLO., 650 17th St.
DES MOINES, IOWA, 418 W. Sixth Ave.
*DETROIT, MICH., 700 Antoinette St.
DULUTH, MINN., 14 West Superior St.
*EL PASO, TEXAS, 109 No. Oregon St.
ERIE, PA., 10 East 12th St.
FT. WAYNE, IND., 1635 Broadway
GRAND RAPIDS, MICH., 148 Monroe Ave.
HARTFORD, CONN., 18 Asylum St.
*HOUSTON, TEXAS, 1016 Walker Ave.
INDIANAPOLIS, IND., 106 No. Illinois St.
JACKSON, MICH., 212 Michigan Ave., W.
JACKSONVILLE, FLA., 11 East Forsyth St.
*KANSAS CITY, MO., 1004 Baltimore Ave.
KNOXVILLE, TENN., 602 So. Gay St.
LITTLE ROCK, ARK., 223 W. Second St.
*LOS ANGELES, CAL., 5201 Santa Fe Ave.
LOUISVILLE, KY., 455 So. Fourth St.
MEMPHIS, TENN., 130 Madison Ave.
MILWAUKEE, WIS., 425 East Water St.
*MINNEAPOLIS, MINN., 107 S. Fifth St.
NASHVILLE, TENN., 234 Third Ave., No.
NEWARK, N. J., 20 Washington Place
NEW HAVEN, CONN., 129 Church St.
*NEW ORLEANS, LA., 837 Gravier St.
NEW YORK, N. Y., 120 Broadway
NIAGARA FALLS, N. Y., 201 Falls St.
*OKLAHOMA CITY, OKLA., 15 No. Robinson St
OMAHA, NEB, 409 South 17th St.
*PHILADELPHIA, PA., 1321 Walnut St.
PHOENIX, ARIZ., 11 West Jefferson St.
*PITTSBURGH, PA., 535 Smithfield St.
*PORTLAND, ORE., 329 Alder St.
PROVIDENCE, R. I., 76 Westminster St.
RICHMOND, VA., 700 East Franklin St.
ROCHESTER, N. Y., 89 East Ave.
*ST. LOUIS, MO., 112 North Fourth St.
*SALT LAKE CITY, UTAH, 209 So. Main St.
SAN ANTONIO, TEXAS, 201 Villita St.
*SAN FRANCISCO, CAL., 235 Montgomery St.
SCHENECTADY, N. Y., 1 River Road
*SEATTLE, WASH., 811 First Ave.
SPOKANE, WASH., 423 Riverside Ave.
SPRINGFIELD, MASS., 1387 Main St.
SYRACUSE, N. Y., 113 So. Salina St.
TACOMA, WASH., 950 Pacific Ave.
TAMPA, FLA., 112 Cass St.
TERRE HAUTE, IND., 701 Wabash Ave.
TOLEDO, OHIO, 520 Madison Ave.
TULSA, OKLA., 409 South Boston St.
UTICA, N. Y., 258 Genesee St.
WASHINGTON, D. C., 1405 G St., N. W.
WATERBURY, CONN., 195 Grand St.
WORCESTER, MASS., 340 Main St.
YOUNGSTOWN, OHIO, 16 Central Square

*Stock of lamps at these points

LAMP FACTORIES

BUFFALO, N. Y.
CLEVELAND, OHIO
EAST BOSTON, MASS.
NEWARK, N. J.
OAKLAND, CAL.
ST. LOUIS, MO.
WARREN, OHIO
YOUNGSTOWN, OHIO

Auditorium, Showing Miniature Stage and Specially Designed Lighting Units



Model Show Windows

Living Room of the Model Apartment

Street Lighting Exhibit

Individuals or groups are always welcome. The Institute is open from nine to five every weekday except Saturday. Special arrangements may be made for groups at night. Further details regarding the Institute may be obtained and arrangements for visits made by writing the Edison Lighting Institute, Edison Lamp Works of the General Electric Co., Harrison, N. J., or by telephoning Harrison 8000, extension 380.